PERFORMANCE OF FUZZY CONTROLLER FOR UPFC TO ENHANCE POWER SYSTEM QUALITY

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ABSTRACT

This paper presents a new control method to compensate the power quality problems through a three-phase unified power flow controller (UPFC) under non-ideal mains voltage and unbalanced load conditions. A unified power flow controller (UPFC) using a fuzzy logic controller (FLC) has been proposed. The results obtained through the FLC are good in terms of dynamic response because of the fact that the FLC is based on linguistic variable set theory and does not require a mathematical model of the system. Moreover, the tedious method of tuning the PI controller is not required in case of FLC. Simulations are carried out using MATLAB/Simulink to validate the theoretical findings.

KEYWORDS: FACTS Applications, UPFC, PI Controller

INTRODUCTION

Unified power flow controller was widely studied by many researchers as an eventual method to improve power quality of electrical distribution system. The function of unified power quality conditioner is to compensate supply voltage flicker/imbalance, reactive power, negative-sequence current, and harmonics. In other words, the UPFC has the capability of improving power quality at the point of installation on power distribution systems or industrial power systems. Therefore, the UPFC is expected to be one of the most powerful solutions to large capacity loads sensitive to supply voltage flicker/imbalance The UPFC consisting of the combination of a series active power filters (APF) and shunt APF can also compensate the voltage interruption if it has some energy storage or battery in the dc link.

Now-a-days there has been growing interest in applying fuzzy theory to controller design in many engineering fields. The fuzzy controller has very attractive features over traditional controllers. It is easy to be implemented in a large scale nonlinear dynamic system and not so sensitive to the system models, parameters and operation conditions. In particular human knowledge can be included in control rules with ease. Therefore investigation of fuzzy theory application in power system control grows rapidly.

The present project is an attempt to understand what the fuzzy PI controller is and how well it can perform in comparison with the traditional PI controller. The fuzzy PI controller is better than the traditional for the non-linear systems.

SHUNT ACTIVE POWER FILTERS

Shunt active power filter compensate current harmonics by injecting equal-but-opposite harmonic Compensating current. In this case the shunt active power filter operates as a current source injecting the harmonic components generated by the load but phase shifted by180 deg. This principle is applicable to any type of load considered a harmonic source. Moreover, with an appropriate control scheme, the active power filter can also compensate the load power factor. In this

way, the power distribution system sees the non linear load and the active power filter as an ideal resistor. The current compensation characteristic of the shunt active power filter is shown in figure
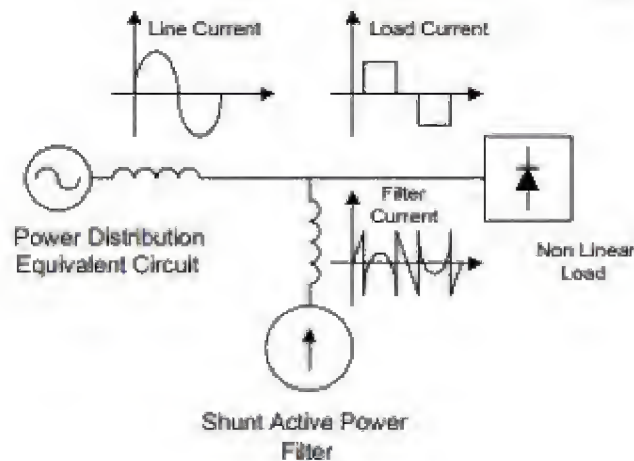

Figure 1: Shunt Active Power Filters

SERIES ACTIVE POWER FILTERS

It is well known that series active power filters compensate current system distortion caused by non-linear loads by imposing a high impedance path to the current harmonics which forces the high frequency currents to flow through the LC passive filter connected in parallel to the load. The high impedance imposed by the series active power filter is created by generating a voltage of the same frequency that the current harmonic component that needs to be eliminated. Voltage unbalance is corrected by compensating the fundamental frequency negative and zero sequence voltage components of the system.
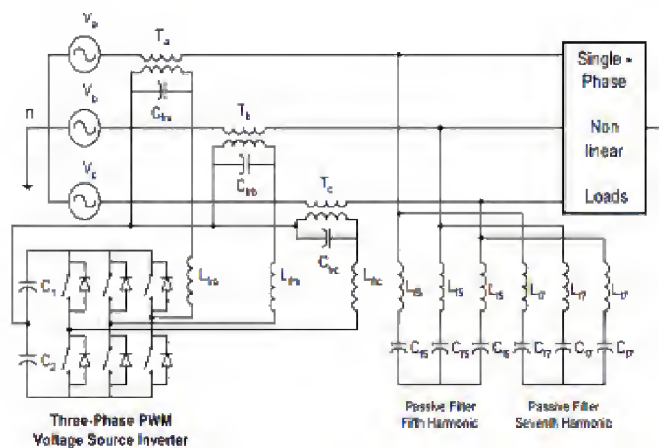

Figure 2: Series Active Power Filters

UNIFIED POWER FLOW CONTROLLER

The provision of both STATCOM and SSSC can control the power quality of the source current and the load bus voltage. In addition, if the SSSC and STATCOM are connected on the DC side, the DC bus voltage can be regulated by the shunt connected STATCOM while the SSSC supplies the required energy to the load in case of the transient disturbances in source voltage. The configuration of such a device (termed as Unified Power Flow Controller (UPFC)) is shown in Figure 3.
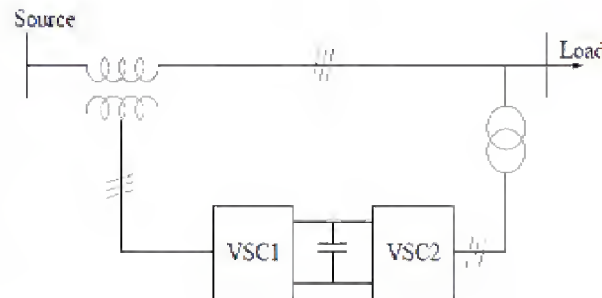
Figure 3: Unified Power Flow Controller

MODEL OF SELF –TUNED FUZZY PI CONTROLLER

The fuzzy PI controller is determined by a set of control rules rather than by two constants proportional and integral gains. Fuzzy controller has data base and rule base, the function of data base is to offer necessary information to the rule base in the form of membership functions. The basic function of rule base is to signify the control policy of control engineer in the form of set of production rules as

If (process operator) then (control output)

The rules used for the FLC are chosen as follows:

If e is P and De is P, then output is P.

If e is P and De is N, then output is Z.

If e is N and De is P, then output is Z.

If e is N and De is N, then output is N.

SIMULATION RESULTS AND DISCUSSIONS

To confirm the proposed control method, digital simulation using MATLAB SIMULINK has been carried out.

The Fuzzy logic based self tuned PI controller is used to generate gate pulses for each leg of Voltage source converters of UPFC.

The simulation is done firstly with unbalanced R-L load. Below figures explain that the Fuzzy logic based controller is able to force the source to deliver the balanced currents by compensating reactive power.
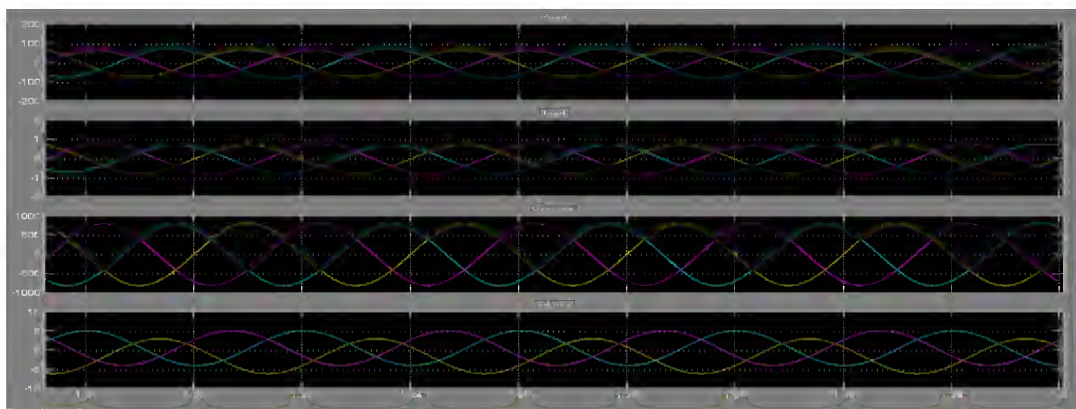

Figure 4

Waveforms of Load Voltage, unbalanced load current, balanced source current, source voltage with unbalanced load
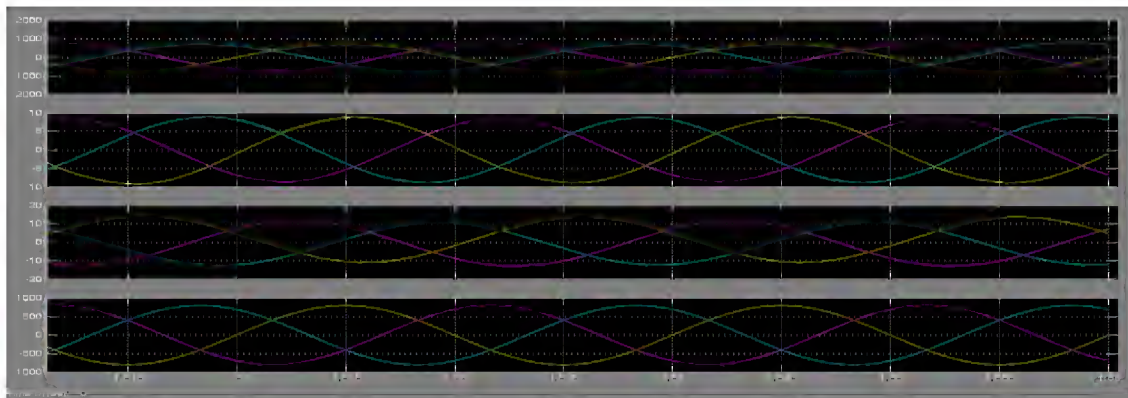

Figure 5

Waveforms of Load Voltage, Nonlinear load current, balanced source current, source voltage with application of nonlinear load

The second simulation is done with nonlinear load. Non linear load is chosen using three phase bridge rectifier with resistive load. The above figure. explains the waveforms of Load Voltage, Nonlinear load current, balanced source current, source voltage with application of nonlinear load. Now again the Fuzzy logic based controller is able to force the source to deliver the balanced currents by compensating reactive power so eliminating the harmonic current flowing in the source side thus decreasing the possibility of harmonic resonance occurred in the system especially a system with capacitor bank. Also, we can see in the same figures that the system settles faster with the fuzzy logic controller. The simulation results prove the effectiveness of the proposed fuzzy logic controller of UPFC.

CONCLUSIONS

This project bestows the model and simulation of fuzzy logic based UPFC. The simulation is approved for both linear and non-linear loads. The fuzzy controller is different from traditional controller as it endeavors to realize the operator's knowledge rather than mathematical equations of plant. The fuzzy rule base for fuzzy controller and as well as fuzzy rule base for gain updating factor are designed. The proposed fuzzy based controller is proven to improve the performance of traditional controller. MATLAB based simulation results have confirmed the efficiency of the design method. It extensively increases the power system stability. It is obvious from the simulation results that to add a fuzzy controller for UPFC is potential alternative to traditional controller.

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